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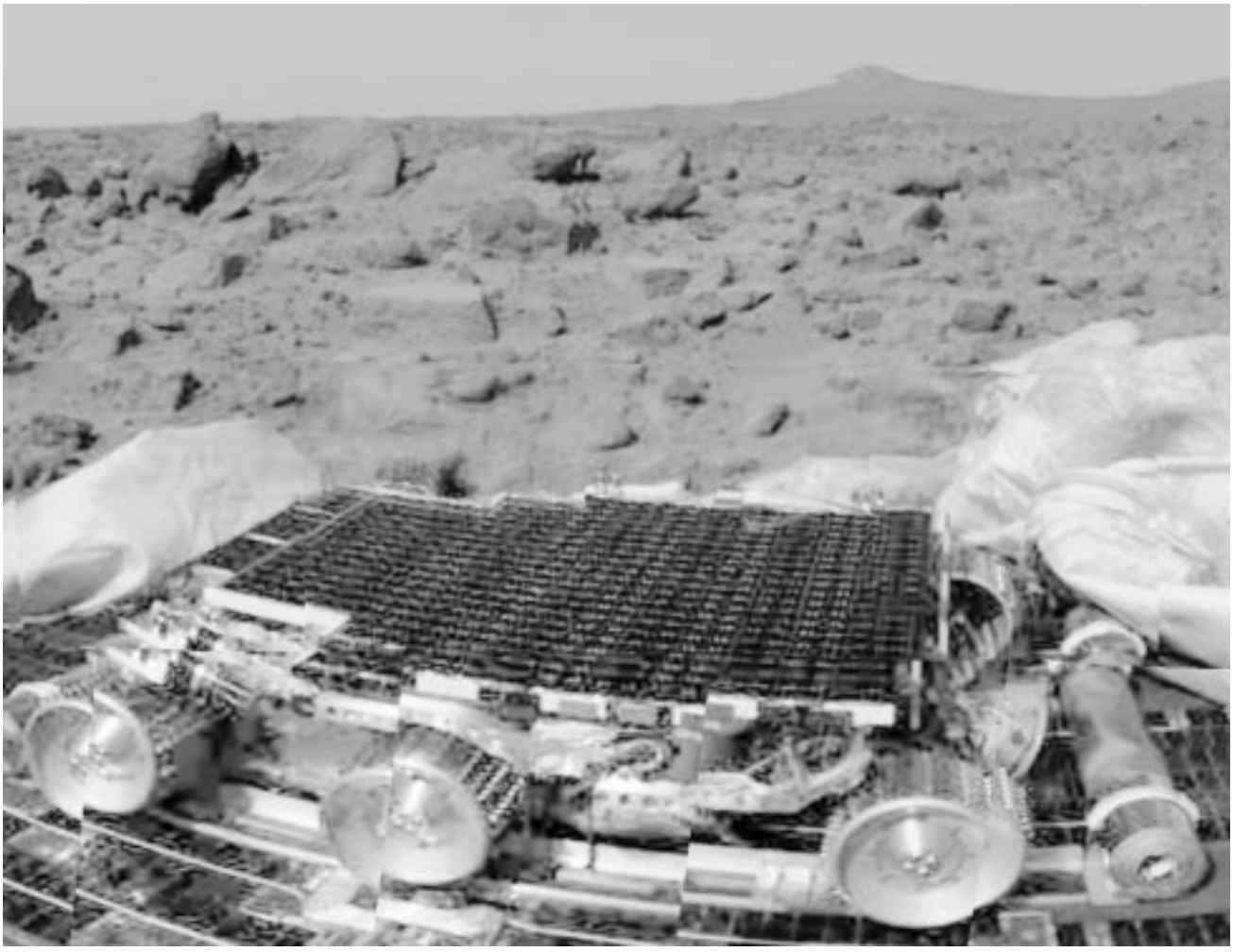
Mars Pathfinder

NASA's Mars Pathfinder spacecraft -- a novel mission to send an inexpensive lander and roving prospector to the surface of Mars -- has concluded its primary mission, fulfilling all of its objectives and returning a wealth of new information about the red planet.

The robotic lander, which continues to explore an ancient outflow channel in Mars' northern hemisphere, completed its milestone 30-day mission August 3, 1997, capturing far more data on the atmosphere, weather and geology of Mars than scientists expected. In all, Pathfinder returned 1.2 gigabits (1.2 billion bits) of data and 9,669 tantalizing pictures of the Martian landscape.

"The data returned by the Sagan Memorial Station and Sojourner has been nothing short of spectacular, and it will help provide a scientific basis for future Mars missions, including a sample return, for years to



come," said Dr. Wesley Huntress, NASA associate administrator for space science. "The Pathfinder team's 'can do' attitude not only was critical to overcoming several complex technical challenges during development and cruise, but has carried through the uncharted territory of operating a solar-powered lander and mobile rover on the surface of a planet millions of miles from Earth."

"This mission demonstrated a reliable and low-cost system for placing science payloads on the surface of Mars," said Brian Muirhead, Mars Pathfinder project manager at NASA's Jet Propulsion Laboratory. "We've validated NASA's commitment to low-cost planetary exploration, shown the usefulness of sending microrovers to explore Mars, and obtained significant science data to help understand the structure and meteorology of the Martian atmosphere, and to understand the composition of the Martian rocks and soil."

A new portrait of the Martian environment has begun to emerge in the 30 days since Pathfinder and its small, 10.5- kilogram (23-pound) rover began to record weather patterns, atmospheric opacity and the chemical composition of rocks washed down into the Ares Vallis flood plain. The rover's alpha proton X-ray spectrometer, led by Principal Investigator Dr. Rudolph Rieder, was responsible for making the first in-situ measurements of rocks near the landing site.

"We are seeing much more differentiation of volcanics than we expected to see," said Dr. Matthew Golombek, Mars Pathfinder project scientist at JPL. "The high silica content of one of the rocks we've measured suggests that there was more crustal activity -- heating and recycling of materials -- early in Mars' history than we thought."

Similarly, atmospheric-surface interactions, measured by a meteorology package onboard the lander, are confirming some conditions observed by the Viking landers 21 years ago, while raising questions about other aspects of the planet's global system of transporting volatiles such as water vapor, clouds and dust, said Science Team Leader Dr. Timothy Schofield. The meteorology mast on the lander has observed a rapid drop-off in temperatures just a few feet above the surface, and one detailed 24-hour measurement set revealed temperature fluctuations of 30-40 degrees Fahrenheit in a matter of minutes.

In addition, sweeping, color panoramas of the Martian landscape, created by the Imager for Mars Pathfinder (IMP) team and Principal Investigator Peter Smith, are revealing clear evidence that the surface of Mars has been altered by winds and flowing water.

Sojourner, a robust rover capable of semi-autonomous "behaviors," captured the imagination of the public, which followed the mission with great interest via the World Wide Web. Twenty Pathfinder mirror sites, constructed by JPL web engineer Kirk Goodall and managed by Pathfinder webmaster David Dubov, recorded 565,902,373 hits worldwide during the period of July 1-August 4, 1997. The highest volume of hits in one day occurred on July 8, when a record 47 million hits were logged, which is more than twice the volume of hits received on any one day during the 1996 Olympic Games in Atlanta.

The rover's performance has easily surpassed its designers' minimum expectations. Engineers designed the roving vehicle's electronics, battery power and hazard avoidance features to see it through at least a week of safe roving, not knowing beforehand what conditions it might encounter on Mars. After 30 days, the rover is still healthy and has clocked 52 meters (171 feet) distance, circumnavigated the lander and taken 384 spectacular views of rocks and the lander.

"Sojourner's capabilities to detect hazards and then act on its own to overcome those hazards has been remarkable," said Dr. Jacob Matijevic, Sojourner project manager. "The technology experiments we have been able to perform with the rover's wheels have given us more information about the composition of the Martian soil, as well as rocks around the landing site. Sojourner's durability in this frigid, hostile environment is also showing us that we are on the right track to building smarter, even more durable rovers for future missions."

Pathfinder's primary objective was to demonstrate a low-cost way of delivering an instrumented lander and free-ranging rover to the surface of the red planet. Landers and rovers of the future will share the heritage of spacecraft designs and technologies tested in this "pathfinding" mission.

Part of NASA's Discovery program of low-cost planetary missions with highly focused science goals, the spacecraft used an innovative method of directly

entering the Martian atmosphere. Assisted by an 11-meter (36-foot) diameter parachute, the spacecraft descended to the surface of Mars and landed, using airbags to cushion the impact.

This novel method of diving into the Martian atmosphere worked like a charm. "Every event during the entry, descent and landing (EDL) went almost perfectly," said Richard Cook, Pathfinder mission manager. "The sequences were executed right on time and well within our margins."

Pathfinder landed right on the money, within 20 kilometers (13 miles) of the targeted landing site. The landing site coordinates in Ares Vallis were later identified as 19.33 degrees north latitude, 33.55 degrees west longitude.

The spacecraft's terminal velocity as it parachuted to the ground was higher than expected, said Rob Manning, Pathfinder flight system chief engineer. "Interestingly, we estimated our descent on the parachute at about 60 meters per second (134 miles per hour). Software controlling the retro rockets recorded Pathfinder's speed at about 61.5 meters per second (140 miles per hour) at the time the RAD (rocket-assisted deceleration) rockets fired."

Pathfinder's performance in the Martian atmosphere will be of great value to Mars Global Surveyor, which will aerobrake through the Martian atmosphere to circularize its orbit when it reaches Mars on Sept. 11. The Pathfinder navigation team, led by Pieter Kallemyn of JPL, estimated horizontal wind velocities in the upper atmosphere, which accelerated the spacecraft's descent velocity by about 13 meters per second (20 to 25 miles per hour).

After being suspended from a 20-meter (65-foot) bridle and firing its retro rockets, a 5.8-meter (19-foot) diameter cluster of airbags softened Pathfinder's landing, marking the first time this airbag technique has been used. The spacecraft hit the ground at a speed of about 18 meters per second (40 miles per hour) and bounced about 16 times across the landscape before coming to a halt. The airbag seems to have performed perfectly and sustained little or no damage. To top it off, the spacecraft even landed on its base petal, consequently allowing its thumb-sized antenna to communicate the successful landing to a jubilant team on Earth only three minutes after touch down.

Science data from the surface of Mars will continue to be collected and transmitted to Earth, then analyzed by scientists, as Pathfinder enters its extended mission. The lander was placed in a two-day hybernation period to recharge its battery after the conclusion of the primary mission, and the flight team will begin to power the lander battery off each Martian night now to conserve energy. The rover's batteries remain in good condition, but are not rechargeable.

The Mars Pathfinder mission is managed by the Jet Propulsion Laboratory for NASA's Office of Space Science, Washington, D.C. JPL is a division of the California Institute of Technology, Pasadena, CA.

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